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ABSTRACT

This paper discusses underlying assumptions of user studies and approaches to information systems design, and reviews key issues in the design of information systems in three major areas: (1) factors affecting information seeking and use; (2) formal and informal channels of information transfer; and (3) discipline oriented transfer patterns. Factors discussed include the membership of scientists in social groups served by different information systems, user preference in channel selection, and the effect of the anticipated use of information on information seeking behavior. Discussion of the formal and informal channels of information transfer reviews the role of scientific communication in research and creating knowledge, the patterns of information transfer and use patterns of information as affected by organizational structure, the journal as a standard channel for information transfer, meetings and conferences as informal communication channels, and the roles of the "invisible college" and informal groups in communication. Discipline oriented transfer patterns are discussed in terms of the differences in development between scientific and technical fields and between physical and social sciences. A summary of user studies as of 1979 concludes the paper, and a list of 20 references and a bibliography are provided. (RBF)

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# Information Use and Transfer Studies: An Appraisal

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Introduction

Studies of the transfer and use of information have proliferated with and partially in response to the increased production of new scientific and technological knowledge following World War II. Referred to as "use studies" or "user studies," most have been based on an underlying assumption that knowing how groups and individuals go about gathering and transferring information is essential for effective information system design.

Six of twenty documents studied in preparation for this paper address this assumption. Garvey, Tomita and Woolf (10, p.127) state that the purpose of their study of the scientific information user was to examine user behavior and to isolate patterns of information need and use that may help information specialists improve information services to scientists. Poole (15, p.23) attempts a definition of use studies as "... one which typically investigates the information-processing activities of individuals or groups of individuals." He adds that methodologies have been employed in user studies have included the use of interviews, diaries, request logs, participant-observers and archival analysis. (15, p.23) Between 1966 and 1976, more than five hundred use studies had been reviewed in the various volumes of Annual Review of Information Science and Technology alone. (15, p.27) Crawford (7, p.61) estimated that over one thousand such studies had been completed by 1978. Paisley (14, P.24) in 1968 suggested that behavioral factors affecting information use be included in information system design in one of two ways: they can be studied after the fact to help explain suboptimal system performance or they can form part of the foundation upon which a system design

rests. Rappaport, (16, p.B-134) in a published letter, suggests that system designers and users must collaborate during the design process in order to develop a successful system.

Brittain began chapter five of his monograph on user studies (5, p.148) by expressing the view that while the problem of information needs has been discussed at length, the topic had yet, in 1970, to be dealt with satisfactorally. He felt that this issue was an outstanding problem in science user studies. He further stated that very little was known about the uses made of information by its recipients. In elaboration of these issues, Brittain raised several other points. How much information should be provided? Too much filtering can eliminate the serendipity value of information in precipitating the chance discovery. (5, p.149) Too much information may cause confusion and indicision. Little is known about the long-term effects upon research of exposure or of lack of exposure to information. (5, p.150) Brittain doubts that the solution is to supply all available information to the researcher. (5, p.152) He suggests that we assess how effective existing services are at meeting the needs of an intended user before we attempt to improve the operation of those existing channels. (5, p.155) Results of user studies should be a primary, but not exclusive, element of system design. (5, p.157) User studies should be concerned with the growth and classification of knowledge, the process of creation, the transmission of knowledge, and the human psychological aspects of information flow. (5, p.155) Brittain joins Debons by suggesting that "information" is a relational concept. He says that "A document, in isolation, and unused, may contain data, theory, and references perhaps, but

these contents do not constitute information until they are read and assimilated, thereby placing them in context. (5, p.160) He finally points out that use studies that look only at formal communication channels are quite inadequate as informal channels may carry as much as eighty percent of the communication load. (5, p.161)

Skelton recognized and acknowledged this same underlying assumption as central to the rationale of the British INFROSS studies. (17, p.139) Referring to the large existing body of user studies, she points out that the data derived from them cannot be correlated due to the diversity of methodoligies, methods, samples, scales and definitions used. (17, p.139) She felt that by 1973, user studies had been conducted primarily for one of two main purposes: to explore information flow in specific environments and organizations or to obtain data regarding the operation of specific services and their effectiveness. (17, p.140)

Skelton (17, p.140) and Poole (15, p.24) both cite Paisley in accounting for the proliferation of use studies. The reasons suggested by them are the distrust of the results of previous studies and the prevalence of the conviction on the part of many researchers that each group or environment is unique, defying a common area of reference. (17, p.140)

While each of the researchers discussed raised different points in their work, all agree in acceptance of the underlying assumption of the value of information about information use and users in the design of information systems.

Two extreme positions emerge as possible approaches to information system design. The first of these, Approach 1, takes

the position that information systems should be designed for technical expedience, that users will adapt to the system. No researcher considered in the preparation of this paper suggested this approach, one all too commonly associated with computers.

Garvey, Tomita and Woolf reject this approach, suggesting that nearly every area of information science is concerned with obtaining a better understanding of user needs. (10, p.115) If this is true, can user needs and characteristics be properly ignored in the information system design process? These writers felt that, by 1974, Approach 1 was obviously discredited, that the rational approach to improving information system design is to adapt systems to people, (10, p.115), the central principle in Approach 2.

Approach 2, takes the position that we must design information systems to facilitate existing procedures of information transfer, to adapt systems to users. Garvey and Griffith warn against the possible results of efforts to improve or design effective information systems if Approach 2 is not used. Discussing a seemingly cumbrous process of guiding psychological information through the various informal and formal stages of development, they suggest that the process acts as an intentional filter for substandard scientific information and that to implement changes that would eliminate this process, sometimes suggested by shortsighted designers, would be detrimental to the growth of scientific knowledge. Facilitating information flow is not always a desirable improvement, although speed of operation and disemination is often a consideration of paramount importance to computer system designers. Alternately, it is suggested that

the existing, seemingly inefficient information systems encountered in the scientific fields are desirable as a quality control mechanism, and that system designers must take this fact into consideration. (8, p.362)

The remainder of this paper will discuss factors affecting information-seeking and use, formal and informal channels of information transfer, discipline-oriented information transfer patterns, and the presentation of conclusions.

## Factors Affecting Information-Seeking and Use

That people do not choose to use an information system simply because it exists is attested by the number of references in the literature of librarianship to seldom used and under-utilized services, usually as victims of budget cuts in lean economic times. Certainly, the people who designed those under-utilized systems did not intend for them to meet that fate. Why are some systems used and others not? What factors affect information seeking and use?

In 1968, Paisley pointed out that the individual scientist is a member of numerous groups which are served by different information systems. These groups touch various aspects of the scientist's life. If an information system does interact with a potential user in one or more of these roles, it is likely to remain unused. (14, pp. 3-4)

Paisley identified ten (10) social groups of which an individual scientist might be a member. (14, pp. 4-6)
They are:

1. The scientist within his culture
   The cultural system in which he works sets priorities, provides rewards, and provides support for academic institutions and endeavors.

2. The scientist within a political system
   In the United States, the Federal government is the major source of funding for scientific research. Federal administrators and policies exercise a major controlling influence on which projects are conducted by their funding decisions.

Scientific nationalism is common.

3. The scientist within a membership group

Professional societies publish and, thus, control the official channels of journal publication. Members of these organizations view publication as a means of maintaining visibility (14, p. 16) and of informing others of the results of their work. Some fields, through the extensive use of preprint circulation, refine material reported in formal channels to a greater degree than do others. A field which uses this filtering mechanism may thus improve the quality of the formal channels, resulting in more effective information transfer.

4. The scientist within a reference group

Scientists with similar interests and training often form informal reference groups, which may cross disciplinary lines and attract participants from several membership groups. (14, p. 5)

5. The scientist within an invisible college

The "invisible college" concept was postulated by Derek J. de Solla Price in 1963 as identifying an informal, elite group within a given field comprised of members whose work is of high quality and who are highly productive. (14, p. 5) The members of an invisible college, usually

numbering less than 100, know one another personally and share information. Paisley maintains that an invisible college selects its own society and excludes others. (14, p. 5) Mullins, on the other hand, feels that there really are no invisible colleges because its so-called members are not conscious of membership in such a body. (14, p. 29).

Paisley felt that invisible colleges tend to cluster around specific institutions and that they resemble extended work teams. Journal editors and referees usually constitute an invisible college. Members tend to be alike in training, academic affiliation and professional age. (14, p. 15)

6. The scientist within a formal organization

Formal organizations such as employers tend to integrate several status-levels at one location. They emphasize lines of authority, roles and productivity rather than individuals. They affect access to information channels by enacting policy regarding travel and long-distance telephone use.

7. The scientist within a work team

Paisley considered this the most important system in which the scientist was involved. Members of the work team support one another closely because of the intimate familiarity they have with one another's work. (14, p. 6)

Some members of the work team serve as gatekeepers, those who are active in acquiring information from outside the group and in passing it along to other group members.

8. The scientist within his own head

All other systems support this one which is the seat of motivation and creativity. It is within the individual cognitive structure of the scientist that the relevance of information may be perceived. (14, p. 6)

9. The scientist within a legal/economic system

Many information seeking and use activities of scientists are constrained by such legal considerations as patents, copyrights and the competitive value of current information.

10. The scientist within a formal information system

Formal information systems, such as libraries and technical information centers exist independently of the scientist and of other systems. Operators of those systems have found that users prefer a two-way negotiation process, that a system will not be used if it is thought troublesome to use.(14, p. 19) Paisley speculates that as bibliographic control of formal channels improves, and as research results are made more readily available, the future will witness less tolerance for duplicated research than is presently the case. (14, p.20)

The designer of an effective information system must, then, begin with the realization that his intended user is a member of a complex

society and is thus a member of many groups. The designer must decide how he is going to reach a given user group based upon his ability to identify the appropriate channel serving that group.

Identification of the group in which the intended user population is to be found and selection of an appropriate channel through which to communicate with that group is only a beginning, however.

The study of information use and transfer has, as we have said, been characterized by a lack of standardized methodology, objectives and concepts. Vickery, in 1973, identified concepts which he observed were common to user studies up to that time. The concepts fall into the following categories:

1. Environment
2. Recipient
3. Message
4. Channel
5. Source

After grouping concepts in the appropriate categories, he was able to construct a relational model for concepts which interrelate in specific questions of information use and transfer. Regarding the recipiant, Vickery provided a model of concepts related to the volume of the search, the recipient's search purpose, and his degree of concentration within his own field. Concerning the message, he provided a model of concepts related to the type of message sought and the age of the message sought. Regarding channels, Vickery's models dealt with the type of channel used, the form of primary medium used, the form of secondary medium used and success encountered during searches. (19,p. 43-45)

User preferences in channel selection were studied by Allen and Gerstberger. Their study identified nine (9) information channels and

provided a basis upon which to determine an order of preference among them based upon four criteria. The criteria were: (4, p. 4)

1. Accessibility - no consideration was given to expected reliability of information expected
2. Ease of use
3. Technical quality - no consideration given to accessibility of channel
4. Degree of experience using channel

The channels were: (4, p. 7)

1. Literature
2. Vendors
3. Customers
4. External sources
5. Technical Staff
6. Company Research
7. Group discussion
8. Experimentation
9. Other company division

They concluded that channel selection among the group studied was based almost solely on accessibility of the channel. The most accessible channel was usually the first used. User perceptions of accessibility are influenced by experience using a particular channel. Perceived technical quality influences the channel of first choice, but only moderately. User acceptance or rejection of ideas was found to be related to the perceived technical quality of the channel that provided the data. (4, p. 23) Other criteria were not found to significantly affect channel selection. An information system designer, then, must make an effort to insure that the system is readily accessible to the user and should also take care to insure that the technical quality

of information provided by the system is high in order to design an effective system.

Ackoff, writing in 1967, (1, pp. 147-152) identified five assumptions often made by business information system designers but which are of questionable validity. They are:

1. Managers lack the information they need

   Managers are often provided with too much information, much of which is irrelevant and confusing.

2. Managers need the information they want

   The request for a great deal of information may sometimes indicate a lack of understanding or competence on the part of the user. The user may want "everything" as a defensive posture, to insure that all relevant data will be available when the user does sort out his needs. However, providing "everything" increases the overload of irrelevant data and may delay or defeat the user.

3. Give a manager the information he needs and his decision making will improve

   Most management problems include too many variables and possibilities to comfortably rely on experience, good judgement or intuition to produce consistently good decisions. Knowledge is needed of how managers use information in the decision process. More needs to be known about the decision process itself.

4. More communication means better performance

   When different parts of an organization have conflicting objectives, communication can immobilize

both.

5. A manager need not understand how an information system operates to use it effectively

While a user need not be concerned with the technical details of system operation, some idea of how the system derives and the bases upon which it provides information enables the user to have confidence in what is provided. During the design stage, user participation in defining the objectives and specifying the output of the system helps to insure that it will serve the user satisfactorally.

Something of a classic, Ackoff's thesis is often included in business and systems analysis texts. While he was writing about business management information systems, the assumptions he highlighted are sometimes made by information system designers in other fields and should be cautiously kept in mind.

The anticipated use to which information will be put has an effect on information-seeking behavior. Clark and James (6) studied the effects of personal attitudes, characteristics and anticipated use on information-seeking activities. Their study dealt with three groups who were going to be required to respond in different fashions to information. The first group was to respond to questions by mail only. The second group was told to anticipate a group discussion of the information. The third group was instructed to prepare for debate of the material with live adversaries.

It was found that all of the groups tended to seek supportive information which conformed to responents' personal attitudes and char-

acteristics. Exposure of one's views to peer evaluation did not result in a greater preference for supportive information. (6,p.242)

It was also found that between those who held extreme beliefs and those who held only moderate beliefs, those holding extreme beliefs sought supportive material far more frequently than those who did not. (6, p. 242) Those who were insecure about their status also sought supportive information with higher than normal frequency.

Clark and James concluded that the anticipated use to which information will be put profoundly affects selection in choice of information to use.

Formal and Informal Channels of Information Transfer

The factors affecting information-seeking behavior, use, and transfer have thus far been examined in relation to individuals. While it is necessary for information system designers to be conscious of these factors, it is economically unlikely that information systems will be tailored to the needs and characteristics of single individuals. A more economically realistic approach is to design systems to serve identifiable groups of people through established channels of communication developed within those groups. Before turning our attention to those groups, some understanding of formal and informal channels of information use and transfer is needed.

Formal channels are the media of public record, the printed conference proceedings and the journal article and monograph. Informal channels are informal consultation among people working in similar research areas by mail, through conversation, at meetings and the sharing of draft papers and preprints. The communication flow in any given group is through a combination of formal and informal channels.

Garvey and Griffith in an important study of scientific communication, differentiate between formal and informal channels. They found the flow of information through informal channels to be relatively free of filtering. The individual researcher selects his material and the people with whom he wishes to communicate. The disseminator is the initial judge of the quality of the work and circulates it informally among his peers for confirmation of the worth of the work and for suggestions for its improvement. The work is thus thoroughly evaluated by a number of knowledgable people prior to exposure of the work to the criticism it will

encounter in the formal domain of published journal literature. (8, p.360)

In the early stages of development, scientific information in the informal domain may be fragmented and incomplete, understandable only by specialists working in related areas. When the material is prepared for dissemination to formal channels, the work must be fully reported and developed so as to provide a context for appraisal of worth by knowledgable non-specialists that compose the larger scientific community. (8, pp.360-361)

The boundaries between formal and informal domains are often ambiguous. The authors suggest that this ambiguity is intentional and acts to prevent unevaluated material from entering the formal domain. Non-scientists often misunderstand this state of affairs and seek to remove the ambiguity of the boundary. If permitted, this would be detrimental to the scientific enterprise. (8, p.362)

Research reaches the formal channels through a series of stages. During the initial twelve to eighteen months, from the inception of work until the researcher can complete and defend his work, he is generally not communicative about it. (8, p.355) The most important step in the process is when scientific information is transferred from the informal to the formal domain of journal publication. (8, p.358) After the appearance of the journal article the work is related to other articles dealing with similar subject matter until they become collected into a corpus of coherent knowledge which represents an acceptable, current understanding of the subject. This transpires within a two or three year period. At about the same time, the article is collected in a review. (8, p.359) After perhaps ten years, the

results of the article are incorporated into the general body of knowledge that forms the basis of theories. (8, p.360)

Allen and Cohen, in a study of the patterns of information transfer in two laboratories, formulated and tested two hypotheses pertaining to the relationship between formal and informal communication channels in them. First, they felt that the structure of the technical communication network is influenced by two factors, the structure of the formal organization and of the informal work and friendship relationships within it. Second, people who occupy key positions in the laboratory communication network, termed "gatekeepers," demonstrate a high degree of contact with technical activity outside of their laboratory. This is attributed to a better acquaintenceship with formal journal and report channels and to a greater degree of contact with other members of the scientific community from outside their own organizations than their colleagues. (3, p.13) Individual gatekeepers use a variety of sources. Those who specialize in the "state-of-the-art" rely more on formal literature sources while those specializing in particular applications tend to communicate orally without outside contacts. Gatekeepers tend to be important people in the organizations in which they work. They tend to serve as first-line supervisors in laboratories. The authors note that management often fails to take full advantage of gatekeepers by failing to provide them with liberal travel budgets and long distance telephone access. (3, p.18) They suggest that gatekeepers be encouraged in these ways, that their behavior be reinforced and encouraged. (3, p.19)

Turning to formal channels, several researchers have studied transfer and use patterns of information as they are affected by

organizational structure. Allen studied the effects of the organization the individual researcher within it. The organization determines lines of authority, reporting, and communication. The formal organization influences both the pattern of technical discussion and the direction which research projects will take. A functional form of organization was proposed in which colleagues sharing the same assignment and having similar technical backgrounds are located near one another spatially and organizationally. (2, p.9) Architecture was seen as an important factor affecting communication within an organization. (12, p.15) In one study cited by Allen, it was noted that the probability of communication declines drastically as the distance between people increases, ceasing virtually altogether at twenty-five yards. (2, p.11) Architects must be made aware of how the design of research facilities can either inhibit or facilitate information transfer.

Lin and Garvey (12) point out that a strength of the formal organization is that it allows identification of every member of the system. Allen and Cohen found that the influence of the formal organization on technical communication was stronger than that of informal organizations. A researcher with a new idea is likely to transmit it to his supervisor before anyone else. (3, p.16) In another view, Paisley reminded us of the importance of the formal information system of libraries which transcend the boundaries of individual organizations. (14, p.6) He concedes, though, that the work team is probably the single most significant information source for the scientist and for the technologist. (14, p.10)

The other formal channel of primary importance is the journal. It is the standard channel for the transfer of information in the learned fields to the formal domain.

The author of a journal article typically begins work approximately twenty-eight months prior to article publication. The first twelve months are spent completing the work. An additional seven months are needed to produce the final manuscript of the article. (10, p. 123) Productive scientists typically work on more than one article at a time. (10, p.124) After progressing through increasingly detatched informal channels, the work is submitted in article form to a journal. Once this step is taken, the information contained within the manuscript is obscured from the public until publication. The author will probably cease other forms of dissemination with article submission. An interval of nine months typically elapses between submission of the manuscript and publication in the journal. (8, p.358) This period is often extended due to initial rejection of the article by the journal of first submission and the time which elapses between that event and resubmission of the article to another journal. The author will typically select a journal that he feels will reach a particular audience. (9, p.172) Prestige of journals varies, forming a stratified hierarchy within a given field. Higher status journals contain more recent citations. Authors are quite sensitive to the relative prestige of the journals to which they submit their work. (12, p.23) A similar stratification occurs among authors over a period of time which is related to their experiences with acceptance of articles submitted to particular journals. An author will

submit his work to more prestigious journals first, resorting to succeedingly less prestigious journals as his work is successively rejected. As time goes by, an author tends to find his "place" in the hierarchy, eventually submitting his work directly to those journals which have previously accepted his work. (8, p.358)

Formal journal channels may fail to reach their intended audience. Allen and Gerstberger found that engineers were reluctant to use their journal literature because they did not understand it. (4, p.20) They suggested that engineering societies take their findings seriously and change the type of articles they are publishing from highly theoretical, academic studies to material of a reasonably high technical level but which is understandable to the average practitioner. (4, p.21) This principle might be extended to other fields in which the concerns of researchers are far removed from those of practitioners.

Moving to informal channels, the areas which have received the most attention are participation in meetings and conferences, circulation of preprints and paper drafts prior to publication and of unofficial associations with others engaged in similar areas of research.

Garvey and Griffith suggested that authors of presentations at conferences derive the most benefit from them in the form of informal criticism of and suggestions for the improvement of their work before submitting it to the journal refereeing and publication process. The authors found the American Psychological Association convention to be an especially important facilitator of informal communication. (8, p.356) Allen, however, warned

that some study is needed to establish how enduring relationships made at conferences are without periodic renewal. (2, p.13)

Garvey and Griffith felt that informal channels serve at least two valuable functions. First, by subjecting their work to the refining process of peer criticism, they expose it for evaluation prior to disseminating it widely in formal channels. Second, informal channels are sources for reporting unfinished or incomplete work while the suggestions of others may be of help in advancing it, (8, p.361) a view shared by Lin and Garvey. (12, p.21)

Allen and Cohen found that a system of status and prestige affects the flow of information in informal communication. People of high status will tend to like one another and to keep in contact with one another. Lower status members of a social system will direct most of their communication upward. Their efforts will achieve only a partial response. (3, p.16)

The circulation of preprints of conference proceedings is a common method of stimulating interest in and criticism of research while it is still in the informal stage. (9, p.1169) (8, p.357) (10, p.116) Allen noted that the combination of circulated preprints and conference discussion sessions provided the basis for significant modifications to the author's work. (2, p.13) Convention papers receive a high level of citation, approaching that of books and journals. (14, p.16) Publishing scientific work as conference proceedings can result in their publication in archival form one year earlier than would otherwise be the case. Publication of their work as conference proceedings was also found to have led many authors to delay or to altogether eliminate submis-

sion of their work to formal channels following the conference, providing an important reduction in the amount of material handled by journals. (14, p.18) Preprints are also an important source of current information for young researchers who have not made informal contacts within their fields. (8, p.356)

An important concept in the study of informal communication channels is that of the "invisible college." First proposed by Price in 1963 (Price, Derek J. de Solla. Little Science, Big Science. New York: Columbia University Press, 1963) as applicable tc groups of scientists, the concept has been extended to other groups of knowledge-workers. Simply stated, an invisible college is a group of researchers who, while not members of the same formal organization, share research findings, thinking and criticism on an informal and supportive basis. More than just an informal work group, an invisible college is an elite group whose work is of unusually high quality and whose members are highly productive. The number of members of an invisible college in any particular field is approximately the square root of the number of people working in that field. Due to the relatedness and high quality of their work, the numbers of an invisible college are connected through cross-citations. Identification of the members of these groups is more certain when such a group has been historically identified than when trying to determine membership by predictive means. (12, p.17) Alternative methods of study of the invisible college have been suggested. First, quality measures are predicated and contacts within fields are mapped on the basis of qualitative measures. Alternately, identifying contacts through citations might preceed the application of qualitative

criteria. It is uncertain to what extent quality of work and cross-citation overlap in an invisible college. It is difficult to determine even the number of invisible colleges that exist in a particular field.

Crane, in a 1968 study, provided what Allen termed "the first really convincing empirical support for the invisible college hypothesis..." (2, p.16)

Paisley suggested a self-conscious role on the part of members of invisible colleges. He felt that invisible colleges select their members and exclude others. (14, p.5) A single scientist may be a member of more than one invisible college. (14, p.14) Invisible colleges center on particular institutions. This may not be conscious, however, as journal referees and editors are thought to respond more favorably to concepts, methodologies and conceptual orientations with which they are familiar and toward which they may be predisposed by their particular academic training. (14, p.15)

In an illuminating paper reporting the investigation of the roles of informal groups in scientific communication, Griffith and Mullins studied groups of workers who were involved in reformulating the conceptual framework of their discipline. Referring to such groups as "radical" and "revolutionary," they were found to be highly organized and to engage in a high level of communication with one another. These groups have an acknowledged leader, a geographical center and a relatively short, intense lifespan. By announcing their new conceptual reorganizations, such groups provide the basis for clearly dividing the field

between those who accept the new view and those who do not. (11, p. 960) Two leadership roles may be present, either in a single person or in two people. An intellectual leader serves three primary functions: to lay the conceptual foundation for the work of the group, to make public statements on research and theory on behalf of the group, and validation of the work of others. An organizational leader arranges funding, meetings and facilities, and arranges for dissemination of the work of group members through formal channels. The organizational leader also arranges that group members obtain jobs which will enable them to contribute to the work of the group and also arranges grants and fellowships for that purpose. There is a perceived conscious direction of the group's efforts toward particular problems. Continued contact with students, from among whom the group recruits new members, is important to the group's survival. A single-minded approach often demonstrated by such a group earns it the enmity of other workers in the field. (11, p.961) The authors observed that coherent groups of this type had a distinguishable approach having broad implications for their field. (11, p.963) As the position of such a group achieves general acceptance, the group becomes integrated with the orthodox extablishment and dissolves.

An illustration of the way in which one such group interacted is provided in an article by Stehling. (18) It recounts the events that led up to the discovery of nuclear fission by members of an invisible college. By sharing work results, criticism and insights, the group produced the discovery. The members of the group, geographically disbursed because of European political considerations during World War II, had formerly worked together in a single institution.

## Discipline Oriented Information Transfer Patterns

As a natural extension of differences of objectives, methods, and concerns of different fields, the development of information transfer patterns tends to differ from discipline to discipline. Garvey, Lin and Nelson recognized these differences and their implications for disigners of information systems. In their concluding paragraph, they warn against patterning of information systems intended for one discipline on an information system intended for another field. (9, p. 1172) The information system that develops within any given field provides an important mechanism for self-regulation of the specialties within it, preventing any specialty from proceeding too far independently down a non-productive path. (8, p. 354) The reality of different discipline oriented systems, however, militates against the emergence of a unified system of formal communication channels serving all disciplines. (14, p. 17) A look at information transfer and use patterns in science and technology, followed by a comparison of observed communication channel operation in the physical and social sciences, should help to illustrate these difficulties.

The majority of research into discipline oriented information use and transfer patterns has focused on scientific and technological fields. (15, p. 24) As reported by Paisley, Allen isolated the primary distinction between the information transfer activities of scientists and technologists. Scientists were found to rely more heavily upon formal literature sources while technologists rely upon informal oral sources for information. (14, p. 10) Paisley suggests that part of the difference is attributable to the longer training and accustomed use of formal channels by scientists. Technologists, on the other hand, tend to consult with others informally, seeking sources both in-

ternal and external to the organizations employing them. (14, p. 11)

Garvey, Tomita and Woolf note a similar distinction between the methods of information transfer practised by scientists and technologists. Their paper is concerned primarily with scientists, identifying several reasons why scientists use journals. First, the scientist uses journals as a means of maintaining visibility and for gaining professional recognition. Next, the scientist publishes his work in journals so as to add it to the body of scientific knowledge. The scientist also uses the information in journals to further his own work. (10, p. 116) Scientists are often engaged in multiple research ventures at a given time, (10, p. 118) and thus require different sorts of information at different stages of their work. There is a sequential temporal order in which they need these different information types as the research enterprise progresses. (10, p. 119) The scientist is, however, constantly seeking information that will help him to place his work in context with other related work. (10, p. 121)

Scientists working in basic and applied fields have somewhat different information needs and thus resort to different channels. Their needs are similar when attempting to formulate solutions, select a data-gathering strategy or design equipment. Basic scientists have greater need for information that will aid in the perception or definition of a problem and to fully interpret data. Applied scientists demonstrate greater information needs as an aid to integrating their work with other current, related work, (10, p. 125) thus prompting them to rely more heavily on the technical report than basic scientists who tend to rely on the journal. (10, p. 126) Journals also emerge as the preferred source of information for scientists working in a new area. (10, p. 127)

Lin and Garvey felt that scientific communication is far more ef-

fective than mass communication due to the identifiability of the scientific group and the similarity of interests among its members. (12, p. 24) They note with incredulity the fact that considerable resources have been expended on the development and operation of scientific information systems prior to obtaining comparative data on the performance of various indexing methods. (12, p. 29) Work is needed to develop concepts of discipline - particular information transfer and use to facilitate systematic investigation of the relationships which exist between information and its intended users. (12, p. 32)

In 1970, Brittain noted that, compared with the number of user studies then extant that dealt with science and technology, there was a dearth of user studies in the social sciences. Coverage of the various social science disciplines was uneven, with education and phychology receiving disproportinate shares of attention. (5, p. 146) Brittain noted that methods developed for use studies in the physical sciences had been used in the social sciences, probably inappropriately. Research based on methods developed for a different field may be of little value and difficult to relate outside that intended field. (5, p. 147, p. 156)
User studies in both the physical and social sciences have been conducted in the absence of firm concepts or theories. (5, p. 162)

Garvey, Lin and Nelson, comparing information transfer patterns in the physical and social sciences, noted that the production of knowledge as represented by transfer of work to the formal journal literature takes longer in the social sciences. Each step in the process occurs in a shorter period of time in the physical sciences. (9, p. 1166) Social scientists began preprint circulation twenty-eight months before journal publication, while physical scientists be-

gan preprint circulation only sixteen months before publication. Physical scientists generate and circulate more preprints than do social scientists. The delay between manuscript submission and article publication is shorter for the physical sciences, nine months as opposed to fifteen months for the social sciences. Meeting presentations in the physical sciences are published more frequently, approximately one-third of them being subsequently published while the rate for such material was only between one-fifth and one-sixth for social scientists. Social scientists are also subjected to substantially higher rates of manuscript rejection. Core journals in the social sciences publish previously rejected manuscripts approximately six times more frequently than was the case in the physical sciences. (9, p. 1167) In addition to these difficulties, it was found that the total interval between submission of the manuscript and eventual publication was considerably longer for the social sciences. (9, p. 1168)

The slower processes typifying the social sciences carry over into informal channels as well. Social scientists disseminate fewer preprints, while physical scientists made more premeeting reports than did social scientists. (9, p. 1169) Physical scientists informally disseminate more intensely, in a shorter period of time and more effectively than do social scientists. Social scientists seek information at meetings more intensely than do physical scientists. They also seek to make informal contacts at such meetings more actively. (9, p. 1170) The two groups differ as to the medium preferred as an alternative to the journal. The social scientist more frequently chooses the book while the physical scientist most frequently chooses the technical report. (9, p. 1172) The findings of this study bear out Brittain's position that methods employed in use studies for one group are inappropriate for another.

Skelton, reporting on the British INFROSS study reported somewhat different findings. She maintained that information seeking behavior of social and physical scientists does not exhibit any marked differences. (17, p. 154) Belying this conclusion, however, is a table comparing information seeking behavior of physical scientists with that of social scientists. Two examples should suffice. When comparing information sources preferred by the two groups, the physical scientist preferred journals, trade literature and handbooks while social scientists prefer monographs and journals as formal sources. The two groups also differ in their willingness to delegate literature searching, with the physical scientist willing to delegate searching while the social scientist tends to conduct his own research. Skelton does, however, recognize the need for standardizing user study methodologies without indicating at what levels they should be developed. She also indicates that both groups value informal personal contacts. (17, p. 147)

## Conclusions

A readily apparent characteristic of the majority of user studies conducted to date is their specificity within a particular discipline, channel or information system. While perhaps a necessary condition imposed by the varying purposes of the studies, it is unfortunate, as Skelton points out (17, p.139) that the bulk of data generated by user studies defies correlation because of the differences in methodologies, definitions, scales, and samples employed. Lin and Garvey (12, p.6) suggested that a unified conceptual framework in which user study data can be correlated is needed, a sentiment shared by Skelton. (17, p.154) As constituted, the corpus of user studies displays a marked lack of such a unified conceptual framework. This characteristic may reflect irreconciliable differences that divide channels and disciplines and may thus continue to resist development of an all-encompassing theory of information transfer and use. In the absence of such a theory, the liklihood of developing a viable, effective general-purpose information dissemination or retrieval system that will serve across disciplinary lines seems remote. Addressing this problem, Paisley (14, p.24) as long ago as 1968 suggested that middle-range theories, neither too close to discipline or channel oriented information-use data nor too far from general information systems theory are needed.

Numerous workers in the field seem to agree on a desirable direction for future research. Brittain (5, p.149) suggests that knowledge of the way in which information is used would provide insight into ways of satisfying information needs. Lin and Garvey (12, p.23) state it a little differently, suggesting that know-

ledge about the uses of information channels and the nature of the information sought from those channels would help information system designers to insure that more useful information is included in them. Skelton (17, p.140) calls for a theoretical concept that links users and systems theory, and Martyn (13, p.17) feels that knowledge of how information is used is what is now needed. Brittain, (5, p.148) suggesting numerous areas for further research, proposed investigation of the relationship between information and action, or, how information is used. Information use, then, emerges as an area ripe for investigation.

Finally, the literature of user studies reflects the universal acceptance by workers in this area of the rationale that knowing how groups and individuals go about gathering and transferring information is essential for effective information system design. This concept is likely to remain a central feature of user studies in the future.

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